MCO Magnetically Coupled Pressure Monitor

The Challenge

Multi canister overpack cap. Inset – cap with pressure indicator recessed in the top. A magnet located 8 inches below the needle rotates in response to internal pressure changes.

The large quantity of uranium metal fuel from the Hanford N Reactor is stored in the two water-filled K Basins. The Hanford Spent Nuclear Fuel (SNF) Project is charged with moving the fuel from the current location in close proximity to the Columbia River to interim dry storage. To accomplish this, the fuel will be vacuum-dried and stored in 400 large new canisters called Multi-Canister Overpacks (MCOs). The MCOs in turn will be placed in storage tubes at Hanford's Canister Storage Building. The fuel is quite old and often in a damaged condition. The damage can result in bare uranium being exposed to residual water remaining in the MCOs after drying. As the water reacts with the uranium fuel, hydrogen gas will be generated with the potential to pressurize the canister to some extent.

The safety of a Multi-Canister Overpack is established by calculations showing that pressure limits of the vessel will not be exceeded but "defense in depth" drives the desire for confirmatory information. Data reflecting the pressurization of the MCOs will also be used to make judgments with respect to the eventual shipment of the N reactor fuel to a geologic repository. The need to vent the MCOs prior to shipment or the ability to ship without further processing will depend in part on the buildup of gas within these canisters.

The challenge is to monitor this pressure increase over decades of dry storage time in a manner which does not result in labor intensive handling of the MCOs with resulting personnel radiation exposure. The introduction of a monitoring device also should not result in any additional penetration of the MCO pressure boundary.

Benefits and Features

- Indicates internal pressure with no intrusion into the fuel canister
- Senses pressure build-ups of up to 600 psi
- Fits into existing process ports with no design change

Current Approach

Under the current plan, a maximum of 6 MCOs will be extensively instrumented for 2 years to understand the trend of gas accumulation. A sample of gas will also be collected from these few MCOs but no more frequently than quarterly. The remainder of the MCOs would have no monitoring without the technology currently demonstrated.

New Technology

The monitoring device of choice should measure pressure on the inside of the MCO and transmit that information to an easily read device on the outside. The approach taken here is to mount a Bourdon gauge in one of four process ports that penetrate a stainless steel MCO shield plug. The shield plug is the top fixture welded to the cylindrical canister of fuel. A magnet is attached, through a series of miniature gears, to the gauge such that an increase in pressure results in a rotation of the magnet. The entire gauge/magnet assembly is covered with a welded plate that completely closes the process port and isolates the MCO interior. Normally a cap is welded over the shield plug and it is on this cap that a compass-like magnetized needle gauge is mounted. This needle senses the rotation of the internal magnet in the shield plug, rotates in tandem with the magnet, and provides an indication of internal pressure.

Demonstration Description

A prototypic stainless steel MCO shield plug and cap were used for the demonstration to keep dimensions and materials the same as in a future deployed version. The gauge/magnet assembly was mounted in a process port and the needle gauge mounted on the cap. Configurations corresponding to full-scale indications of both 100 and 600 psi were tested. Pressure on the MCO interior side was maintained with Argon gas and monitored with a second calibrated pressure gauge. The primary goal of the demonstration was to demonstrate that the new magnetically coupled pressure gauge on the exterior of the MCO cap read within 10 percent of the reading given on the interior side. Secondary goals were to demonstrate that the magnet did not affect plasma arc welding on an MCO and that a canister storage building storage tube (simulated by a low carbon steel cylinder) did not affect that performance of the needle/magnet coupling.

Demonstration Results

Comparison of the applied and measured pressure showed that both accuracy and precision of the new gauge were within 3 to 4 percent in both the 100 and 600 psi demonstrations. The storage tube surrounding the MCO did not affect the measurements. The presence of the magnet associated with the new gauge did not perturb welding of the shield plug to a simulated MCO shell. The demonstration has resulted in a decision to procure 10 units early in FY 2000 for engineering evaluation expected to lead to deployment in FY 2001.

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